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SEASONAL ABUNDANCE, SIZE, AND SEX RATIO OF FISHES CAUGHT WITH GILL NETS IN ST. ANDREW BAY, FLORIDA

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ABSTRACT—Sampling with monofilament gill nets was conducted for 72 consecutive h every 2 weeks from 10 January to 27 December 1973. The total catch of 11,230 fishes consisted of 70 species and 1 hybrid. Fishes of 10 families comprised over 97% of the total catch. Pelagic fishes comprised 46% of the total catch. The 10 most abundant species were: gulf menhaden, *Brevoortia patronus*; spot, *Leiostomus xanthurus*; sea catfish, *Arius felis*; pinfish, *Lagodon rhomboides*; blue runner, *Caranx crysos*; pigfish, *Orthopristis chrysoptera*; Atlantic croaker, *Micropogon undulatus*; bluefish, *Pomatomus saltatrix*; Spanish mackerel, *Scomberomorus maculatus*; and yellowfin menhaden, *Brevoortia smithi*. Periods of abundance for these 10 species were: gulf menhaden, spot, and pigfish in fall, winter, and spring; sea catfish and bluefish in spring and summer; Spanish mackerel in spring, summer, and fall; blue runner in late spring and summer; pinfish in spring and fall; Atlantic croaker in fall; and yellowfin menhaden in spring. Most of the specimens were adults. Females generally outnumbered the males. Species composition of, and inferences of seasonal abundance from, catches by gill net, by trawl, and by beach seine were compared.

Studies of catches of fishes with gill nets in bays and estuaries of the Gulf of Mexico are rare. Such studies were undertaken by personnel of the Panama City Laboratory of the National Marine Fisheries Service during a field program to investigate the ichthyofauna of St. Andrew Bay, Florida. Comparisons of catches in relation to webbing material, time of day, and water depth were made (Pristas and Trent, 1977); the selectivity of gill nets in catching estuarine and coastal fishes was determined (Trent and Pristas, 1977); and the relation of fish catches to frontal periods was noted (May et al., 1976). We present here the results of our analyses of the seasonal abundance, size, and sex ratio of the catches.

The study area in St. Andrew Bay, Florida, in the northeastern Gulf of Mexico (Fig. 1) has been described by Pristas and Trent (1977).

MATERIALS AND METHODS

Sampling was conducted with monofilament gill nets every 2 weeks from 10 January to 27 December 1973. On Monday or Tuesday of alternate weeks, six gill nets were set within 1 h of sunset and fished for 72 consecutive h (collection period). Each net was 33.3 m long and sufficiently deep (3 m) to block a column of water from surface to bottom. Stretched-mesh sizes of the webbing of the six nets were 6.4, 7.6, 8.9, 10.2, 11.4, and 12.7 cm. Fishes were removed from the nets twice daily, and these catches were combined by collection period for data analyses. Our index of abundance was the number of fish of a species, or of all species, caught in these six nets per 72-h period. Net damage never exceeded 10% of the total area of a net before repairs or replacements were made.

For each collection period, mean lengths and sex ratios were determined for a species only when 10 or more individuals of that species were caught. Bony fishes were measured from the most anterior projection of the head to the tip of the middle caudal ray. Total lengths were recorded for elasmo-

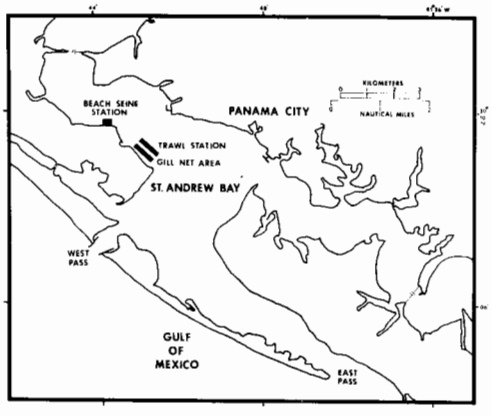

Figure 1. Study area and sampling locations in St. Andrew Bay, Florida.

Table 1. Family, species, and numbers caught by mid-date of each collection period, January–December, 1973. Pelagic species are indicated by asterisk.

	Jan		Feb		Mar		Apr		May			June		July		Aug		Sept		Oct			Nov		Dec		
Family and Species	11	24	7	22	8	21	4	18	2	16	30	13	27	11	25	8	22	5	19	3	17	31	14	28	12	26	Total
													Numbers Caught														
CLUPEIDAE																											
*Brevoortia patronus**	150	440	352	64	233	63	20	101	15				4						1		29	333	21	262	76	393	2,557
*Brevoortia smithi**							79	30	87	2		7	3	1	2				15	2	3	12		10	4		257
*B. patronus × B. smithi**							16	8	24	1									3		7	4		1	2		66
*Alosa alabamae**	5	3	1	4	27	4																			4	3	51
*Opisthonema oglinum**	1		1			5	1	15	3	1	7	2				3		1	3	1				1		2	47
*Alosa chrysochloris**									5	6	1														11	5	28
*Harengula pensacolae**											8				3	1											12
SCIAENIDAE																											
Leiostomus xanthurus	33	241	128	2	324	154	118	88	76	12	40	33	14	14	9	13	7	5	72	2	467	296	21	4	87	8	2,268
Micropogon undulatus						4	9		5	1	1		1		2	4	5	10	55	34	227	47	9	3	10	3	430
Cynoscion nebulosus	1	1	2		3	2	13	21	50	15	6	1		5	1	1	2	2		2	1	1	1	2		1	134
Cynoscion arenarius	1	1	2		2	1	3	6	5	7	8	3	12	6	3	3	4		2	1		1			2	2	75
Bairdiella chrysura							2	8	7																		17
Menticirrhus americanus								2		1	1															3	7
Pogonias cromis									1	1																	2
ARIIDAE																											
Arius felis	6	33	21		89	53	71	80	64	132	98	137	90	79	59	59	26	25	11	3	13	22	21	39	31	3	1,265
Bagre marinus						1	1	1	2	1	1						1	1	5	1	3	11	3	4			36
SPARIDAE																											
Lagodon rhomboides	1				5	23	116	61	87	32	71	44	51	29	17	16	17	17	11	4	71	332	30	24	2		1,061
Archosargus probatocephalus							1		3	4	4		1									1					14
CARANGIDAE																											
*Caranx crysos**						1			44	179	84	242	166	123	29	53	25	4	9	9	30						998
*Chloroscombrus chrysurus**									2		6							1	3	1	1		43	4	2		63
*Oligoplites saurus**								3	11	2	4	1	6		3	12	5	1	3		3	1	1				56
Trachinotus carolinus						1		4	4	17	1	3	2	2	1	3	1	1	3	1	3	1	1		4		53
*Caranx hippos**															1	1				4	22	2	1	1	6		41
*Caranx bartholomaei**															1	5	2	1	2	2	2				1		16
*Vomer setapinnis**											1			1					2						1		5
*Alectis crinitus**																	1										1
POMADASYIDAE																											
Orthopristis chrysoptera	2	26	14		44	1	3	5	32	16	18	12	11	2	3	1	1	2	2			3	84	60	110	53	505
POMATOMIDAE																											
*Pomatomus saltatrix**						105	1		75	16	52	17	38	12	9	13	11	12	12	7	11	7	5	5	21		429
SCOMBRIDAE																											
*Scomberomorus maculatus**						31	15	4	6	12	1	17	34	29	2	1	10	20	7	12	60	10	20		4	1	296
*Euthynnus alletteratus**	4															1	4				16	1	1	5	1		33
SPHYRNIDAE																											
*Sphyrna tiburo**						4			3	5	9					1			10	4	9	1					46
*Sphyrna lewini**																					1		1				2
CARCHARHINIDAE																											
*Rhizoprionodon terraenovae**											1		1	5	7	1		8	2	3	1	2	1	1	1		34
*Carcharhinus limbatus**											1	1	3	1	3	1	1		2	1	4		1	3			22
*Carcharhinus acronotus**											1		2	9			2		1		1	1		1	3		21
*Aprionodon isodon**													1								1	1					3
*Mustelus norrisi**															1										2		3
*Carcharhinus milberti**																								1			1
BOTHIDAE																											
Paralichthys albigutta	3	1			1	1			4	3	2	5		3		1	1	3	1	1	1	4	4		2		41
Paralichthys lethostigma	1																										1
Syacium papillosum																									1		1

Table 1. Continued

Family and Species	Jan 11	Jan 24	Feb 7	Feb 22	Mar 8	Mar 21	Apr 4	Apr 18	May 2	May 16	May 30	June 13	June 27	July 11	July 25	Aug 8	Aug 22	Sept 5	Sept 19	Oct 3	Oct 17	Oct 31	Nov 14	Nov 28	Dec 12	Dec 26	Total
	Numbers Caught																										
ELOPIDAE																											
*Elops saurus**											1		7	12	2		3	1	6		6						38
SYNODONTIDAE																											
Synodus foetens			1								1				1						2	4	3	8	7	2	29
STROMATEIDAE																											
*Peprilus alepidotus**							2	1	6					1	3	1					7	4		1	2		28
*Peprilus burti**				1												1											2
TRIGLIDAE																											
Prionotus tribulus				1		1	1				1	2	1			1				1			2	2	2	2	17
Prionotus scitulus		1	1				1		1	2																	6
RACHYCENTRIDAE																											
*Rachycentron canadum**												2	3		1	1	1	2	4		3						17
LEPISOSTEIDAE																											
Lepisosteus osseus		2		2	4	1	2	1											1			1					14
SOLEIDAE																											
Trinectes maculatus					1				4	1	1	2	3										1				13
ECHENEIDAE																											
*Echeneis naucrates**									1		1		2	2				3	1		1			1			12
EPHIPPIDAE																											
Chaetodipterus faber									1			2				1									2		6
MUGILIDAE																											
Mugil curema																		2							4		6
Mugil cephalus															1						1						2
DIODONTIDAE																											
Chilomycterus schoepfi									1		2			1				1									5
SERRANIDAE																											
Mycteroperca microlepis											1											2			2		5
Centropristis melana																								1			1
Diplectrum formosum																									4		4
MYLIOBATIDAE																											
Rhinoptera bonasus							2	1								2											5
BATRACHOIDIDAE																											
Opsanus beta				2														1				1					4
SPHYRAENIDAE																											
*Sphyraena guachancho**										1		3															4
LUTJANIDAE																											
Lutjanus griseus																1						2					3
OSTRACIIDAE																											
Lactophrys quadricornis						1				1		1															3
BALISTIDAE																											
Aluterus schoepfi																				1							1
LOBOTIDAE																											
Lobotes surinamensis																				1							1
URANOSCOPIDAE																											
Astroscopus y-graecum																										1	1
PRIACANTHIDAE																											
Priacanthus arenatus																			1								1
OPHICHTHIDAE																											
Ophichthus ocellatus											1																1
Ophichthus gomesi																								1			1
TETRAODONTIDAE																											
Sphoeroides nephelus						1																					1
ALBULIDAE																											
Albula vulpes																						1					1
Total number species	12	10	10	7	11	21	21	19	30	26	33	22	23	20	24	28	21	23	29	23	31	30	22	26	30	15	71
Total number individuals	208	749	523	76	733	458	477	440	629	471	436	540	456	337	164	202	130	124	250	98	1,007	1,109	275	449	407	482	11,230

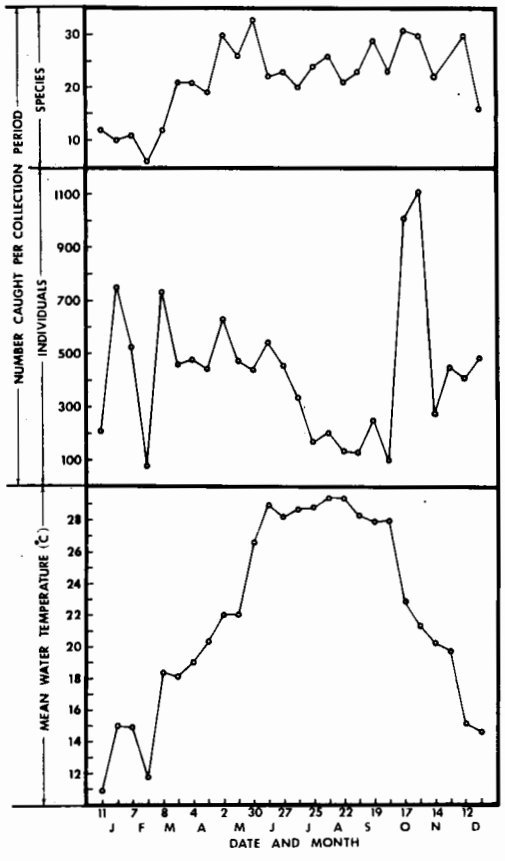

Figure 2. Catches and water temperature by collection period in the study area.

branchs. Sex was determined for a maximum of 25 specimens of a species in each net for each collection period. Fishes with undeveloped gonads were classified as immature, while all others were considered mature. A chi-square test was used to measure deviations from the expected 1:1 sex ratio for each species during each season.

Water temperature was recorded continuously about 1 m below the surface at a pier located about 100 m from the study area using a Peabody Ryan Thermograph[1] (accuracy ± 2% on time and temperature). Temperature for each collection period was expressed as the average of values recorded at 0600, 1200, 1800, and 2400 h.

Summary data from two other ichthyological studies in the bay system were compared with gill-net data obtained in this study. Trawl samples were obtained twice monthly for 1 year (1972–73) with a 10.7-m trawl having 2.5-cm-stretched-mesh webbing in the cod-end (Ogren and Brusher, in press). Beach seine samples were obtained monthly for 1 year (1974–75) with a 20.5 × 1.8-m seine having 1.2-cm-stretched-mesh webbing (Naughton and Saloman, in prep.). All sampling locations are shown in Figure 1.

Catches

A total of 11,230 fishes representing 70 species and 1 hybrid, *Brevoortia patronus* × *B. smithi* (Hettler, 1968), was caught during the study (Table 1). Ten families represented over 97% of the catch. Thirty of the 70 species and the hybrid were classified as pelagic. Specimens of pelagic species comprised 46% of the total catch. Although each species and the hybrid have been reported in Florida waters (Briggs, 1958; Vick, 1964; Turner, 1969), three species (*B. patronus* × *B. smithi*, *Aluterus schoepfi*, and *Lobotes surinamensis*) have not been reported specifically from St. Andrew Bay.

The 10 species caught in highest abundance were: gulf menhaden, *Brevoortia patronus*; spot, *Leiostomus xanthurus*; sea catfish, *Arius felis*; pinfish, *Lagodon rhomboides*; blue runner, *Caranx crysos*; pigfish, *Orthopristis chrysoptera*; Atlantic croaker, *Micropogon undulatus*; bluefish, *Pomatomus saltatrix*; Spanish mackerel, *Scomberomorus maculatus*; and yellowfin menhaden, *Brevoortia smithi*.

Seasonal Abundance

The number of species per collection period ranged from 7 to 33 with fewest in January and February, the months of lowest temperature (Fig. 2). More species were captured as water temperature began increasing in March. The number of species

[1] Reference to trade name does not imply endorsement by the National Marine Fisheries Service, NOAA.

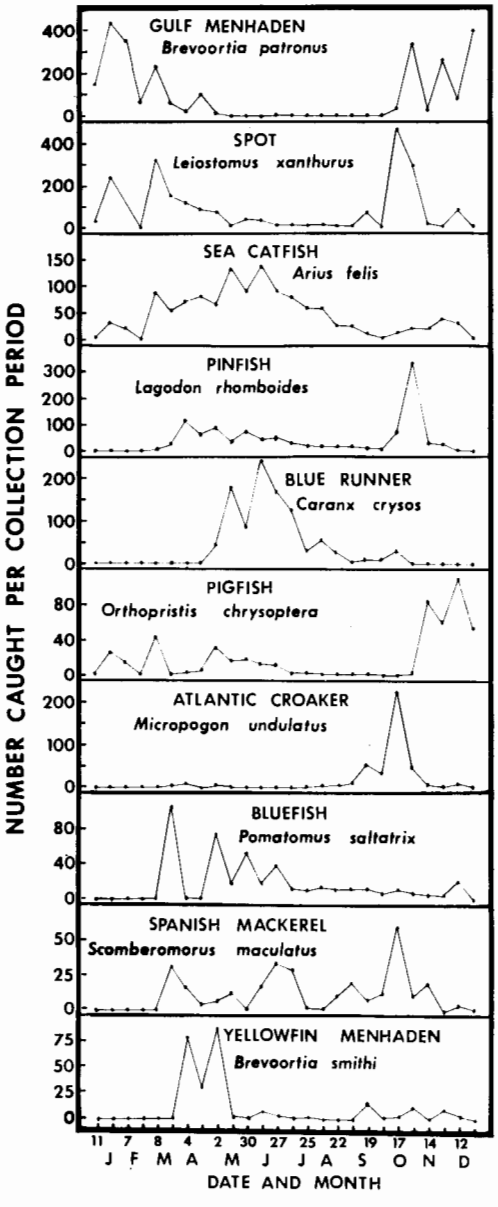

Figure 3. Catches of the 10 most abundant fishes per collection period.

remained high through mid-December. Fewer species were captured during the winter months.

Most species within each family (Table 1) were abundant only during some part of the temperature range. Species belonging to the families Clupeidae (6 species and 1 hybrid), and Sciaenidae (7 species), and Pomadasyidae (1 species) were caught in greatest abundance during low (less than 16°C) or intermediate (16–24°C) water temperatures with the exception of *Harengula pensacolae* and *Cynoscion arenarius*. These two species were caught in greatest abundance during high (greater than 24°C) temperatures. In greatest abundance in intermediate temperatures were all species belonging to the families Sparidae (2 species), Pomatomidae (1 species), and Scombridae (2 species). All species belonging to the families Ariidae (2 species), Carangidae (8 species), Sphyrnidae (2 species), and Carcharhinidae (6 species), were caught in greatest abundance during intermediate or high temperatures with the exception of *Mustelus norrisi*. Two of the three specimens of *Mustelus norrisi* were caught in low temperatures.

Catches of individuals per collection period varied greatly (Fig. 2). Catches from 22 March to 27 June were consistently higher than the annual average. Catches were consistently lower than the annual average from 11 July through 3 October during the periods of sustained high temperature. Highest catches occurred during middle and late October as the temperature decreased. Catches decreased with lowering temperatures in November and December, while catches in January and February fluctuated greatly.

The 10 most abundant species (Fig. 3) were categorized by periods of abundance: gulf menhaden, spot, and pigfish in fall, winter, and spring; sea catfish and bluefish in spring and summer; Spanish mackerel in spring, summer, and fall; blue runner in late spring and summer; pinfish in spring and fall; Atlantic croaker in fall; and yellowfin menhaden in spring.

Size

Most of the individuals of the 10 most abundant species were adults, as all indi-

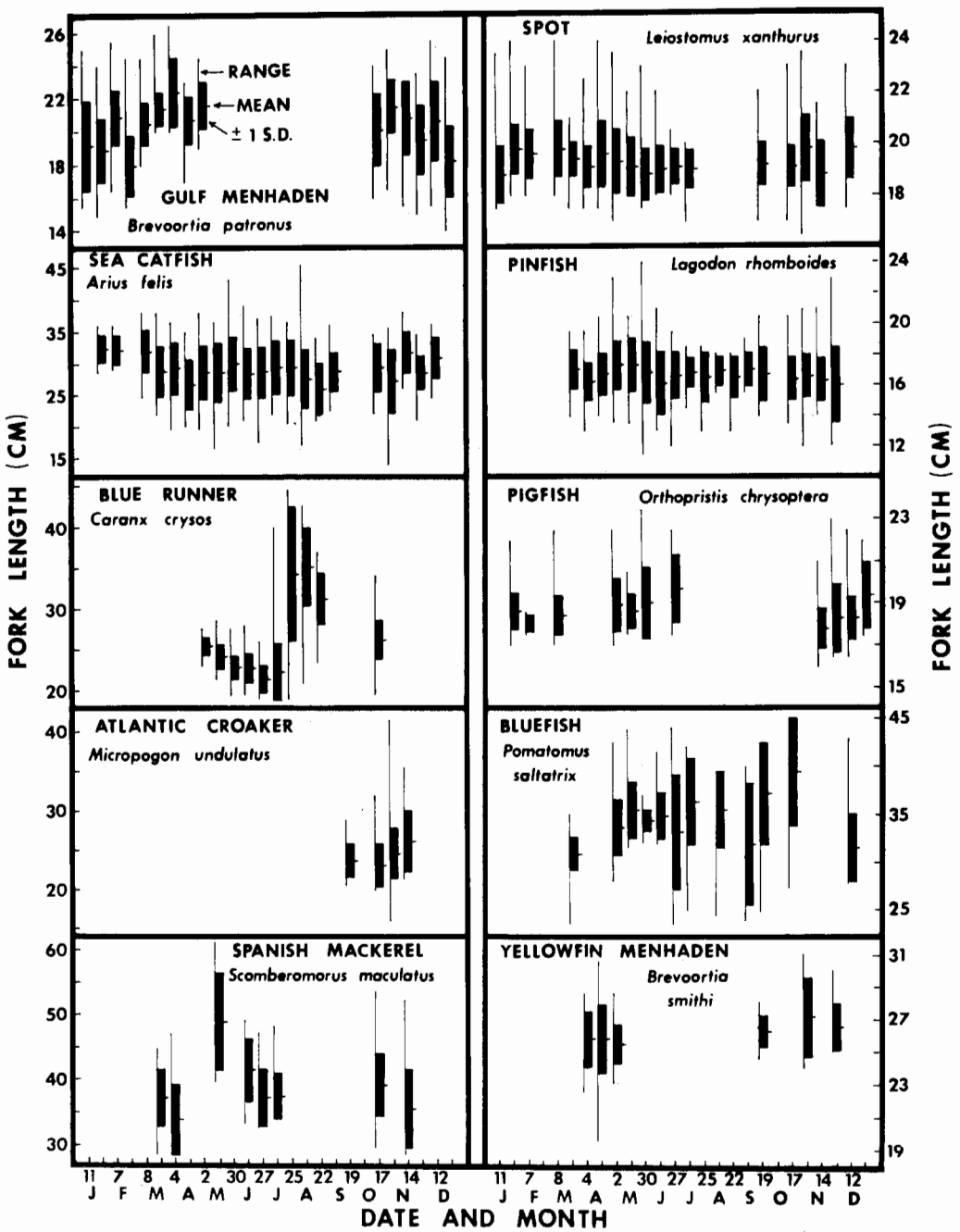

Figure 4. Sizes of the 10 most abundant fishes per collection period.

Table 2. Chi-square (χ^2) tests of expected 1:1 sex ratio by season for the ten most abundant species caught, January–December, 1973

Species	Season	Percent males	Number of males observed	Number of males expected	Degrees of freedom	χ^2
Gulf menhaden	Winter	28.6	269	469	5	89.8**
	Spring	32.8	43	65	3	10.8*
	Summer	—	—	—	–	—
	Autumn	59.7	141	118	4	91.6**
Spot	Winter	35.6	159	223	3	18.9**
	Spring	56.7	97	85	6	9.3
	Summer	49.0	25	25	2	0.8
	Autumn	26.3	39	74	3	33.3**
Sea catfish	Winter	13.5	21	77	2	42.9**
	Spring	24.1	99	205	6	64.6**
	Summer	46.7	72	77	5	22.9**
	Autumn	25.4	31	61	4	15.0**
Pinfish	Winter	—	—	—	–	—
	Spring	38.3	95	124	5	8.7
	Summer	48.7	56	57	5	5.4
	Autumn	34.9	45	64	3	6.7
Blue runner	Winter	—	—	—	–	—
	Spring	52.4	100	95	3	3.3
	Summer	48.7	93	95	4	6.9
	Autumn	50.0	15	15	–	—
Pigfish	Winter	46.8	59	63	3	4.6
	Spring	57.9	33	28	2	3.2
	Summer	—	—	—	–	—
	Autumn	31.6	42	66	2	10.8**
Atlantic croaker	Winter	—	—	—	–	—
	Spring	—	—	—	–	—
	Summer	60.5	23	19	–	—
	Autumn	34.5	40	58	2	9.5**
Bluefish	Winter	—	—	—	–	—
	Spring	54.0	95	88	4	2.7
	Summer	29.8	17	28	3	5.0
	Autumn	40.6	13	16	1	0.6
Spanish mackerel	Winter	—	—	—	–	—
	Spring	45.4	25	27	2	5.7
	Summer	27.3	12	22	1	4.6*
	Autumn	43.3	29	33	1	0.7
Yellowfin menhaden	Winter	—	—	—	–	—
	Spring	39.2	51	65	2	3.9
	Summer	0.0	0	7	–	—
	Autumn	33.3	7	10	1	1.2

— No data or insufficient data for comparison.
* Significant at 95% level.
** Significant at 99% level.

viduals were at a stage of maturity that sex could be determined, and most were larger (Fig. 4) than the minimum lengths for mature fishes reported by various investigators (Tagatz and Wilkins, 1973; Parker, 1971; Hansen, 1970; McKenney et al., 1958; Lund and Maltezos, 1970; Klima, 1959). Length ranges of the 10 most abundant species were:

Table 3. Ten most abundant species caught by each type of gear in St. Andrew Bay, 1972–75

Species	Gill nets (1973)	Trawl (1972–73)	Beach seine (1975)
	Percent of total catch		
Brevoortia patronus	22.8		
Leiostomus xanthurus	20.2		14.1
Arius felis	11.3		
Lagodon rhomboides	9.4		7.8
Caranx crysos	8.9		
Orthopristis chrysoptera	4.5	2.7	0.6
Micropogon undulatus	3.8		
Pomatomus saltatrix	3.8		
Scomberomorus maculatus	2.6		
Brevoortia smithi	2.3		
Polydactylus octonemus		32.7	
Harengula jaguana		14.7	
Symphurus plagiusa		13.1	0.1
Stenotomus caprinus		5.8	
Urophycis floridanus		4.1	
Diplectrum bivittatum		3.1	
Diplectrum formosum		2.6	
Eucinostomus argenteus		2.6	10.4
Anchoa mitchilli		2.3	
Menidia beryllina			64.5
Fundulus similis			0.4
Mugil curema			0.4
Syngnathus scovelli			0.2
Paralichthys albigutta			0.1

gulf menhaden, 14.0–26.5 cm; spot, 16.5–24.0 cm; sea catfish, 14.0–45.5 cm; pinfish, 11.5–24.0 cm; blue runner, 19.0–44.5 cm; pigfish, 16.0–23.5 cm; Atlantic croaker, 16.0–41.5 cm; bluefish, 23.5–44.0 cm; Spanish mackerel, 28.5–61.0 cm; and yellowfin menhaden, 19.5–31.0 cm.

Sex Ratio

Females generally outnumbered the males. In only six instances did males outnumber females (Table 2): spot, blue runner, pigfish, and bluefish in spring; gulf menhaden in autumn; and Atlantic croaker in summer. Of these six instances, only the predominance of male gulf menhaden in autumn was statistically significant. In all other statistically significant deviations from a 1:1 proportion of sexes, females were dominant. These were: gulf menhaden in winter and spring; spot in winter and autumn; sea catfish during all four seasons; pigfish in autumn; Atlantic croaker in autumn; and Spanish mackerel in summer.

Discussion

We are continually confronted with the problem of estimating the abundance of fish populations but must make these estimates with data that are collected with selective fishing gears. Fish populations are, however, heterogeneous in species composition, age, size, condition, behavior, habitat, etc.; all their members are not equally vulnerable to a particular method of sampling (Hamley, 1975).

For example, in St. Andrew Bay, fishes caught by trawling (Ogren and Brusher, in press) and by beach seine (Naughton and Saloman, in prep.) did not, except in one instance, provide the same inferences about seasonal abundance as those made in our study. The trawl caught juvenile spot in greatest abundance in spring and summer; the beach seine caught juvenile spot in greatest abundance in winter and spring; our gill nets caught adult spot most abundantly in fall, winter, and spring. For pigfish, the seine caught juveniles most abundantly in late summer and early autumn, whereas the trawl caught them most abundantly in summer; our gill nets caught adults most abundantly in fall, winter, and spring. The beach seine caught juveniles of only one other species in sufficient quantity to infer seasonal abundance. That species was pinfish, which was most abundant in spring and fall. Adults in our study were also most abundant during spring and fall. The trawl caught juvenile sea catfish most abundantly in fall and juvenile Atlantic croaker in spring and summer. Our gill nets caught adult sea catfish most abundantly in spring and summer and adult Atlantic croaker in fall.

Species composition of catches also differs with types of sampling gear. Of the 10 most abundant species in our study, five (gulf menhaden, blue runner, bluefish, Spanish mackerel, and yellowfin menhaden) were

pelagic species, and these five comprised 40% of the total catch of individuals. These results were in sharp contrast to the results from bottom trawl (Ogren and Brusher, in press) and beach seine (Naughton and Saloman, in prep.) sampling (Table 3). The trawl samples contained two pelagic species (*Harengula jaguana* and *Anchoa mitchilli*) among the 10 most abundant fishes; these two comprised 17% of the total catch of individuals. The beach seine samples contained no pelagic fishes among the 10 most abundant species.

Whether the results of our study indicate greater abundance of pelagic fishes in estuaries and bays of the Gulf of Mexico than previously believed and reported, or whether the frequent occurrence of pelagic fishes in St. Andrew Bay is unique must await studies in other gulf estuaries where sampling gear for pelagic fishes is used. The uniqueness of St. Andrew Bay is its relatively deep water, high salinity, and low turbidity. The occurrence of certain species and large sizes of penaeid shrimps and the occurrence of several species of scombrid fishes in St. Andrew Bay have been attributed to these qualities (Brusher and Ogren, 1976; Nakamura, 1976).

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